Statoil uses remote support for effective machinery management

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The Tjeldbergodden methanol complex is located on the Norwegian coast between Kristiansund and Trondheim, Norway. The facility consists of a methanol plant, a pipeline system (with an associated receiving terminal for gas from the Heidrun field), and an Air Separation Unit (ASU). The complex occupies about 60% of a 250 hectare (617 acre) site zoned for industrial development. Although Statoil solely operates the complex, the three facilities at the site have various owners – Haltenpipe: Statoil (76.875%), Conoco (18.125%), and Neste (5%); Statoil Metanol ANS: Statoil (81.875%) and Conoco (18.125%); Air Separation Unit (ASU): Statoil (53.68%), Conoco (11.88%), and AGA (34.44%).

The challenge has been to construct a plant that combines minimal carbon dioxide and nitrogen oxide emissions with optimal gas utilization. A further goal was to achieve a cost structure that makes the facility competitive in terms of operating costs with other methanol manufacturers. Two things were necessary to achieve this goal. First, the facility had to have a good knowledge of existing technology, such as permanently monitoring their critical rotating machinery for vibration. Second, the facility's management had to be willing to implement innovative technical solutions, such as assessing the condition of their rotating machinery from an offsite location. The information derived from these machinery condition surveys is used by Operations to maintain and improve Statoil's machinery management program. The resulting development work within the project has improved safety, performance, and reliability, while lowering

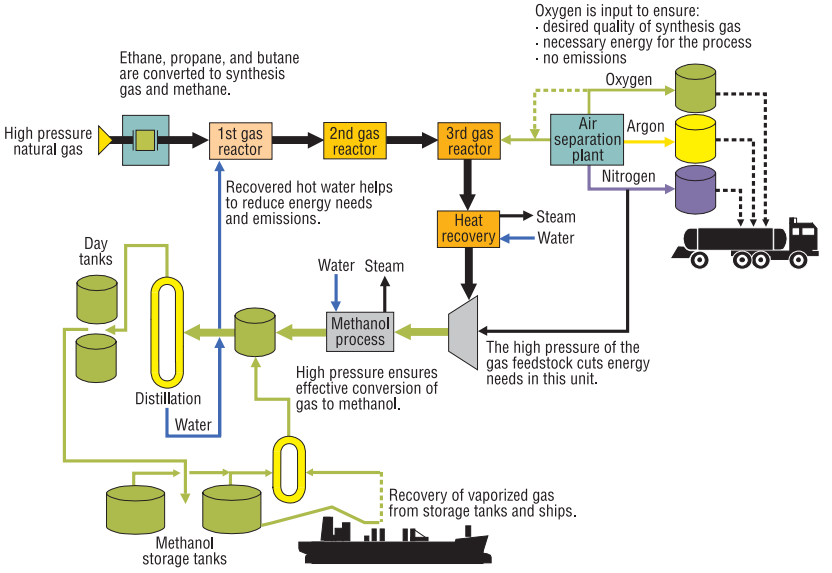

Figure 1. The methanol production process.

emissions and gas consumption. This has helped to make the Tjeldbergodden methanol plant one of the world's most environmentally friendly and productive installations of its kind.

Methanol production process

Three processes are required to produce methanol. The first process is air separation. The second is conversion of natural gas to synthesis gas (syngas). The third is reacting the syngas to methanol. Figure 1 shows this process pictorially.

The process for producing methanol from natural gas was developed in 1923. While it has been modified and improved over the years, the basic process remains the same. At Tjeldbergodden, the natural gas comes through a pipeline from the Heidrun platform, which lies on the Halten bank, 175 kilometers (109 miles) off the Norwegian coast. Although the pipeline has a maximum capacity of 2.2 billion cubic meters (77.7 billion cubic feet) of gas, it currently transports only one-third this much.

Installed machinery protection and management systems

Statoil selected Bently Nevada 3300 Series Machinery Protection Systems for protection of all critical machinery at Tjeldbergodden in 1994. Statoil operation then decided in 1996 to install Bently Nevada Data Manager® 2000 (DM2000) Machinery Management Software. The 3300 Systems were installed on the machines shown in Table 1.

Location	Qty	Machines
Air Separation Plant	1	Booster compressor
	1	Air compressor
	2	Expanders
Methanol Plant	1	Steam-driven turbine/syngas compressor
	1	Steam-driven turbine/generator set
	2	Electric motor-driven pumps
	1	Steam turbine-driven pump
	2	Draft fans

Table 1. Summary of installed machinery protection systems.

The expander in the ASU is an integrally-geared unit driven by an electric motor. A compressor wheel and an expander wheel are located at either end of the high-speed pinion. Substantial vibration analysis has been done on this unit in order to define the abnormal dynamic behavior that causes higher vibration levels.

All of these machinery protection systems have also been connected to TDXnet™ Communications Processors and DM2000.

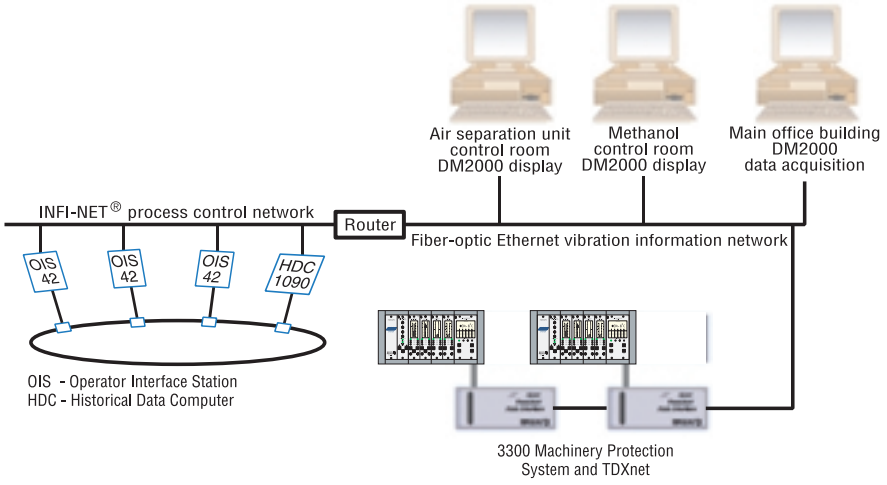

Figure 2. Machinery management system network layout.

Machinery management system advancements

Statoil owns the world's most advanced online continuous machinery management software, DM2000. Their rotating equipment department consists only of motivated, highly-educated, well-trained people, who are adept at vibration measurement and diagnostics. Yet they felt that they still were far from "machinery management." They recognized that their DM2000 system would provide the most value only when its data was available to a broad range of plant personnel. As a result, Statoil's first step was to implement the Bently Nevada philosophy of Move Data, Not People® and make relevant machinery data available to plant personnel at dedicated locations at all times. To accomplish this, the offices, the ASU control room, and the methanol plant control room needed to be linked together to move data to where it was required. Therefore, the DM2000 systems installed throughout the plant were connected by a fiber-optic LAN (Local Area Network).

Establishing this LAN was the first step in building a communications network. The next step was to integrate the data from this Ethernet LAN into their Bailey INFI 90® process control system. Because the Bailey system uses INFI-NET®, a proprietary network, and Statoil did not want to directly tie their "vibration information" Ethernet

network to it, a router was used to connect the two networks (Figure 2).

Benefits of remote diagnostics

At the time of the initial plant startups in 1997, vibration data was monitored and collected using the DM2000 system. A number of vibration problems were detected during the startup, including coupling unbalance, alignment errors, oil whirl, and oil whip. These problems were identified and corrected early with the help of Bently Nevada's Machinery Diagnostics Services Engineers and Tjeldbergodden's Rotating Equipment Engineers. When the plant was running to the customer's specifications, Bently Nevada's personnel left. From then on, the facility was completely operated by Tjeldbergodden's Rotating Equipment Personnel.

The Tjeldbergodden complex.

Statoil's Rotating Equipment Engineers are using the DM2000 system for condition monitoring and machinery diagnostics. They have attended several Bently Nevada training seminars, such as Machinery Diagnostics, Balancing, Getting the most out of DM2000 and MCM2000, and Survey of Machinery Monitoring. Statoil still uses Bently Nevada support through on-site visits or remote surveys using dial-in connections to their DM2000 system by one of Bently Nevada's Machinery Management Services (MMS) Engineers from Norway, the Netherlands or from another Bently Nevada office.

For example, after a sudden stop, an already high vibration condition at the drive end of one of their electric motors exceeded the Alert levels. Statoil's analysis showed that the major frequency component was synchronous with rotating speed (1X). The Bode plots showed a squared relationship between machine speed and vibration amplitude, and the amplitude and phase remained stable over time. Consequently, they reasoned that the high vibration levels were related to an unbalance condition, and they decided to balance the machine's coupling on-site.

Prior to balancing, however, they asked a Bently Nevada engineer to review their data and to confirm their analysis. The Bently Nevada engineer reviewed the data remotely and concurred with Statoil's Rotating Equipment Engineers. There was no need for a Bently Nevada engineer to rush to the office, drive to the airport, and spend hours driving to the site. The vibration problem was addressed in the Dutch office using only a computer, a modem, and the necessary software. The result was a significant cost savings and the additional measure of confidence that Statoil needed prior to balancing. By logging onto their network and looking at the responses of the unit after a correction weight was placed, it was also possible for Statoil's Rotating Equipment Engineers and Bently Nevada to verify that the overall vibration levels had decreased to within specifications.

Conclusions

Although the Statoil site is located far from any Norwegian city or the nearest Bently Nevada office, it is possible to have the expertise of Bently Nevada available 24 hours a day via remote communications. Statoil's progressive actions to install a machinery management network, combine the acquired data with data from their process control system, and make this available to Bently Nevada service engineers anywhere in the world were the keys to success. Our service organization can provide similar capabilities for any DM2000 user, ranging from "per incident" support to provide diagnostic assistance, to regular audits and system operation where the entire machinery management program is outsourced to Bently Nevada. For more information, contact your nearest sales or service professional.